Air Space Total Awareness for Rapid Tactical Execution (ASTARTE)

Paul G. Zablocky
Program Manager, DARPA STO

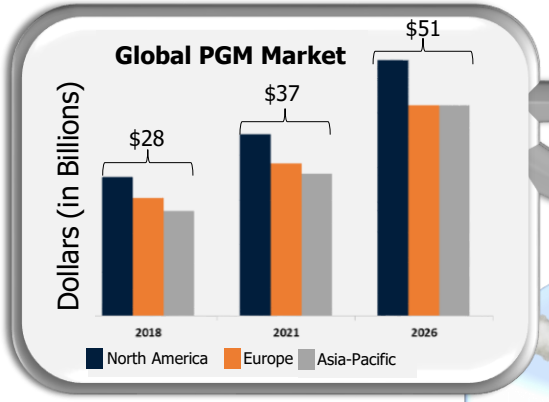
COL Chad Ward
Director, Army Joint Support Team

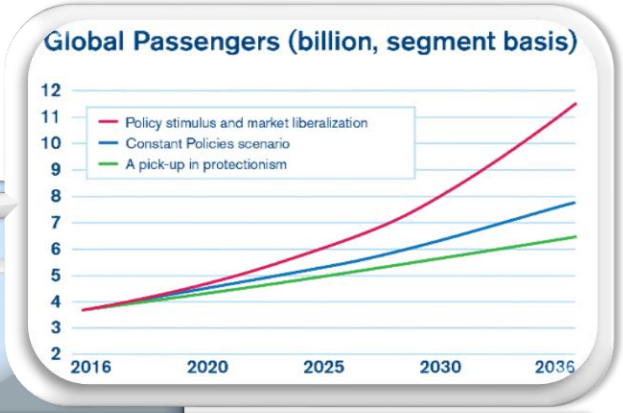
Proposers Day Briefing

21 April 2020

Growing Complexity of Airspace Operations Limits Joint Fires

Airspace usage forecasted to increase ***significantly***; increased PGM use, autonomous technologies, and dynamic battle management initiatives such as ***Mosaic*** and ***Multi-Domain Operations*** will exacerbate problem





18,000 ft.

Stealth platforms operating far forward

Adversary A2/AD and future tech advances limits use of conventional aircraft tracking systems

100km

100km

Army Division Airspace: 100km*100km*18,000ft

A2/AD: Anti-Access / Area Denial
PGM: Precision-Guided Munition

Graphic source: DARPA Artist Concept

ASTARTE will enable dynamic airspace operations in the most complex and challenging environments

Current Airspace Operations

Tactical Airspace Integration System (TAIS)

Graphic source: Army Research Laboratory

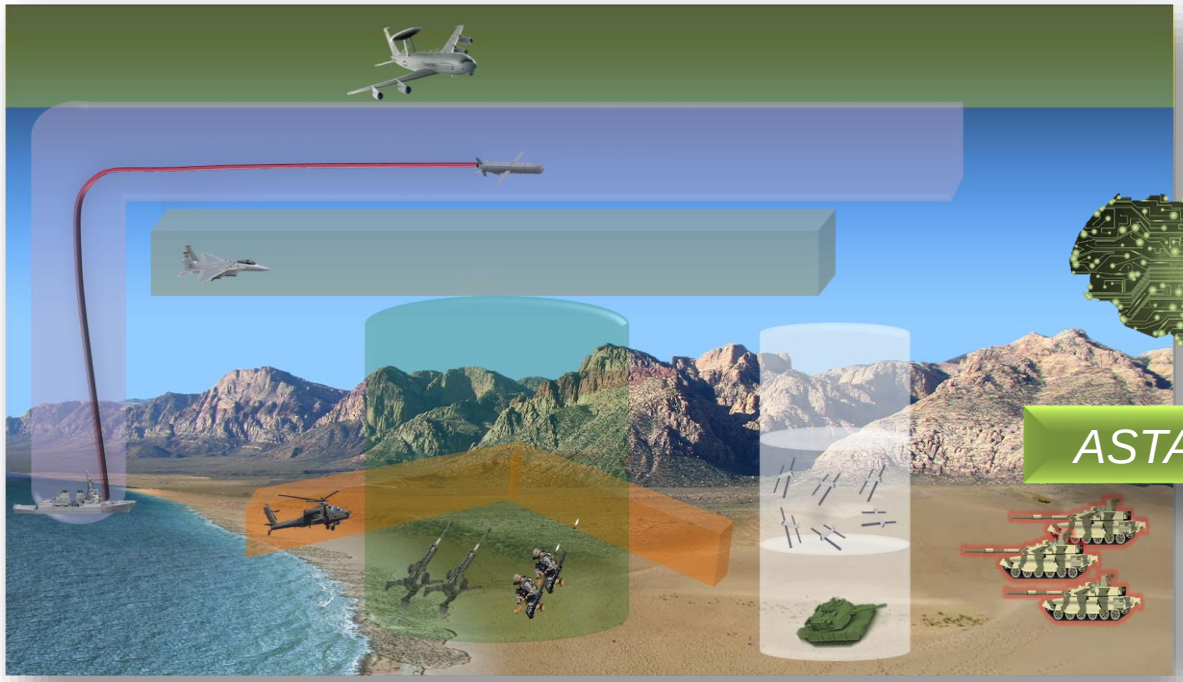
Current

- Digital exchange of 3D Common Operating Picture
  - Tracks, air corridors, ROZs are all ***static***
- Planning and control mostly ***manual*** processes
  - Creation of airspace and fires plans, control measures, and mission/orders
  - Operator clearance of airspace
  - Change of plans, control measures, orders, and commander's guidance
  - Verbal notification of clearance of airspace and fires
- Current techniques result in safety risks and missed mission opportunities

Current tools and procedures prohibit adaptive retasking

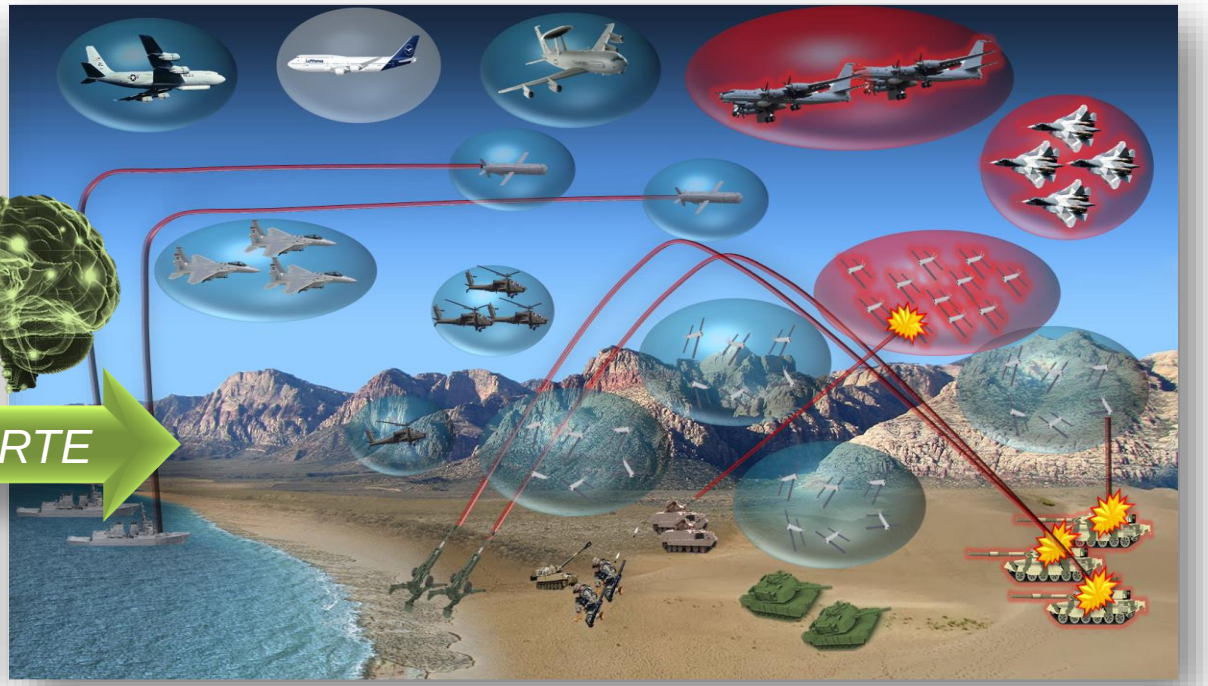
Future Airspace Operations

Current



Graphic source: DARPA Artist Concept

Future



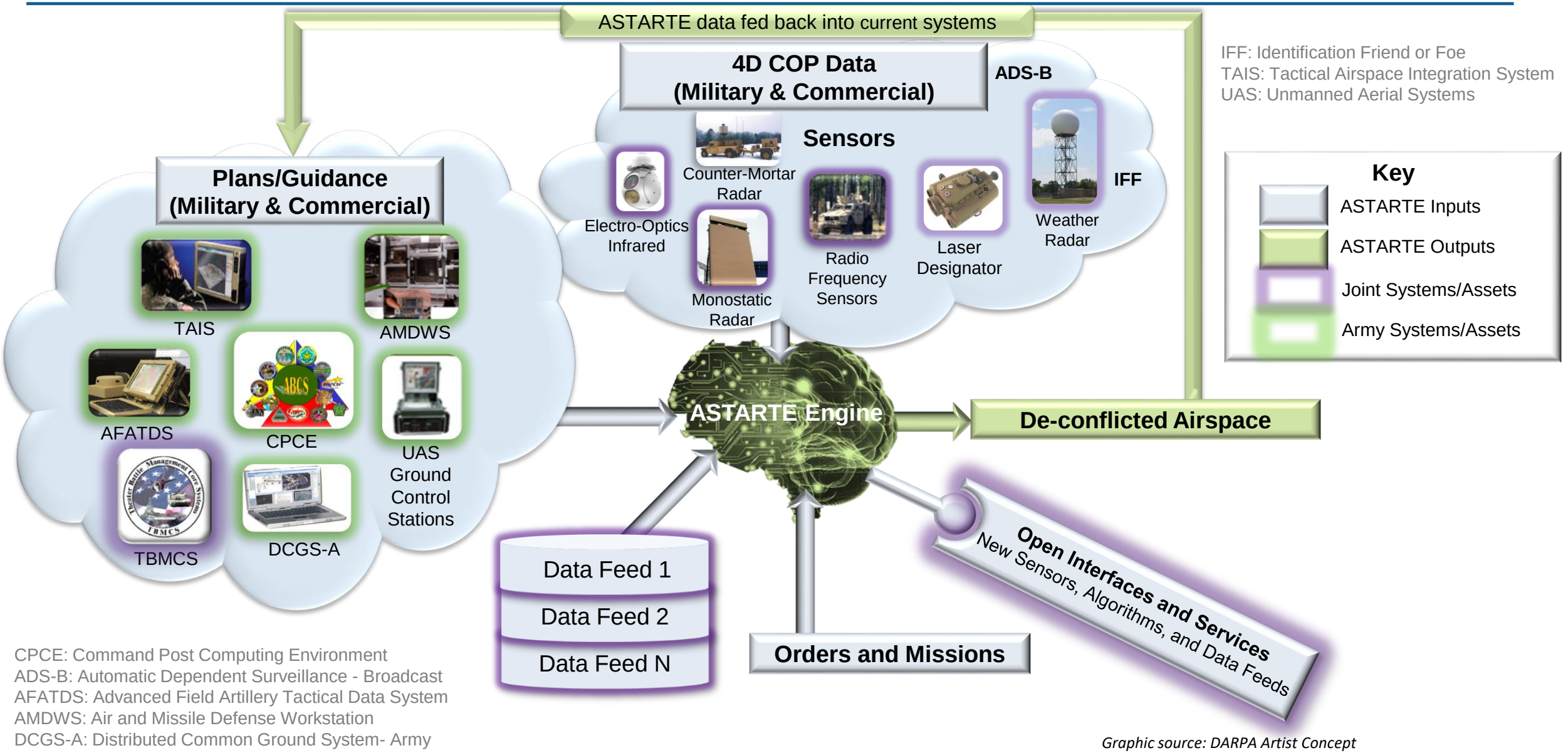
Graphic source: DARPA Artist Concept

ASTARTE will enable dynamic spatial and temporal airspace management and operations

- Seamless, digitally-integrated automation of airspace & fires planning, processing, de-confliction and execution in 4D COP
- Optimized algorithms for airspace/fires clearance and deconfliction COA generation; considers A2/AD effects
- Detects and tracks BLUE, RED and WHITE
- Supports planning for long-range fires and effects (e.g. hypersonics)
- Dynamic mid-mission re-tasking (e.g. Air Interdiction to CAS)

CAS: Close Air Support
COA: Courses of Action
COP: Common Operational Picture

ASTARTE Approach



IFF: Identification Friend or Foe
TAIS: Tactical Airspace Integration System
UAS: Unmanned Aerial Systems

CPCE: Command Post Computing Environment
ADS-B: Automatic Dependent Surveillance - Broadcast
AFATDS: Advanced Field Artillery Tactical Data System
AMDWS: Air and Missile Defense Workstation
DCGS-A: Distributed Common Ground System- Army
TBMCS: Theatre Battle Management Core Systems

Graphic source: DARPA Artist Concept

ASTARTE Technical Areas

Technical Area 1 – Understanding and Decision Algorithms

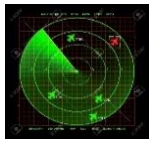
Algorithms

Development of physics-guided algorithms to estimate airspace entities position, forecasts future position with an error ellipse, identify conflicts, assess risk and provides recommendations

- Develops and executes sensor scheme to monitor airspace operations in real time
- Refines airspace entity position and forecasts future position
- Resolves conflicts identified in airspace and fire mission by providing COAs and modifying operations
- Alerts operators to conflicts during operations, offers resolution, and provides risks and rationale

Technical Area 2 – Sensors

Sensors

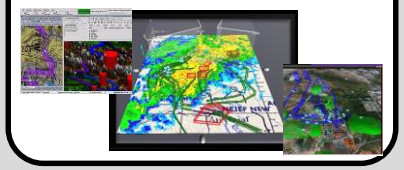


Development of innovative sensor feeds to detect and track aircraft and weapons in A2/AD environment

Monostatic Radar

Technical Area 3 – Virtual Lab Testbed

Virtual Lab Testbed



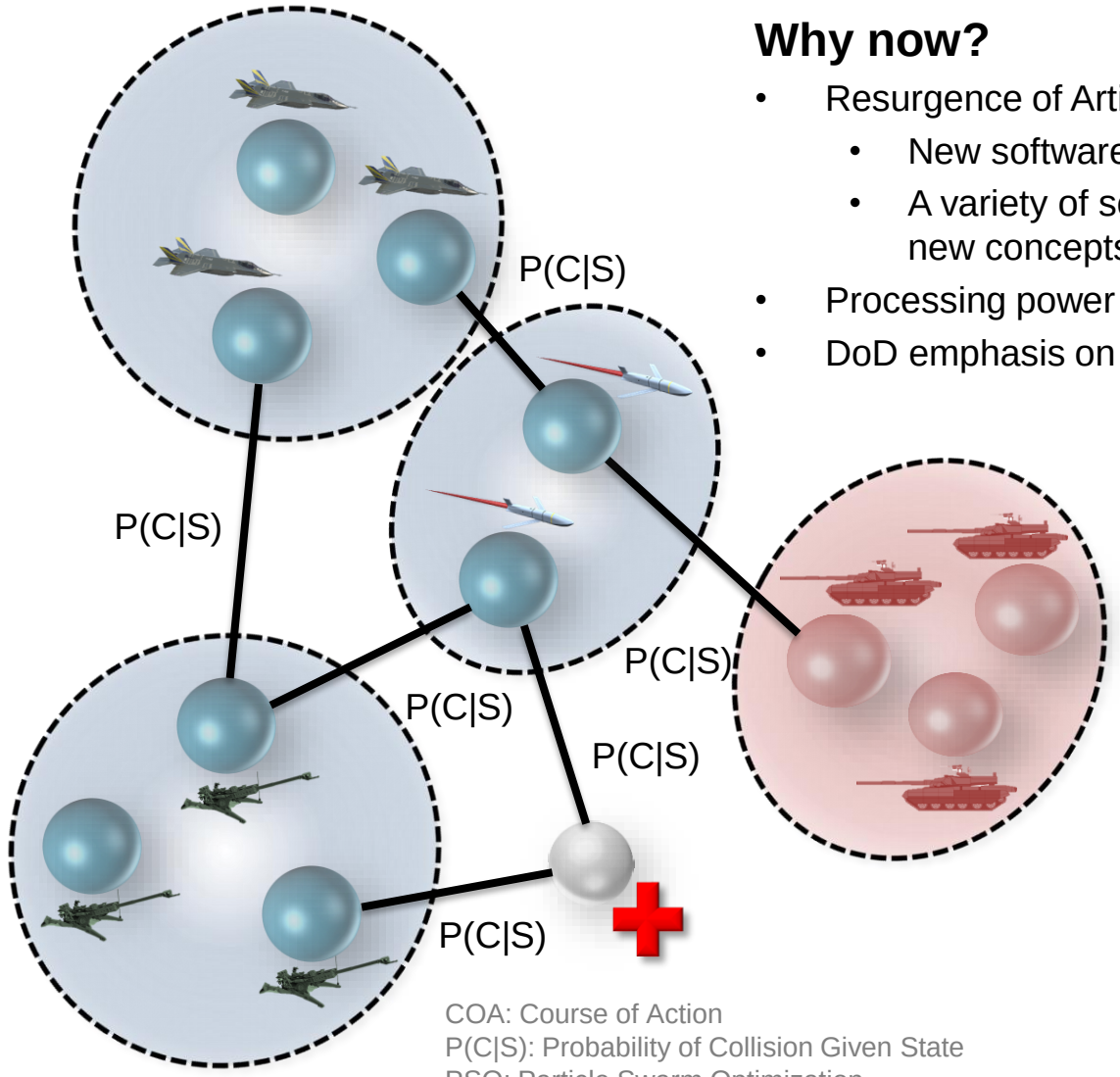
Development of Virtual Machine implementation of existing Army and Air Force systems and interface specifications to sensor network supporting seamless transition from virtual environment to real-world operations

U.S.ARMY

U.S. AIR FORCE

Graphic source: Army Research Laboratory

TA1: Understanding and Decision Algorithms



COA: Course of Action
P(C|S): Probability of Collision Given State
PSO: Particle Swarm Optimization

Graphic source: DARPA Artist Concept

Why now?

- Resurgence of Artificial Intelligence (AI) resulted in:
  - New software architectures for solving large, incomplete problems
  - A variety of software development tools to rapidly implement and experiment with new concepts
- Processing power is now sufficient for problems on the scale of airspace management
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

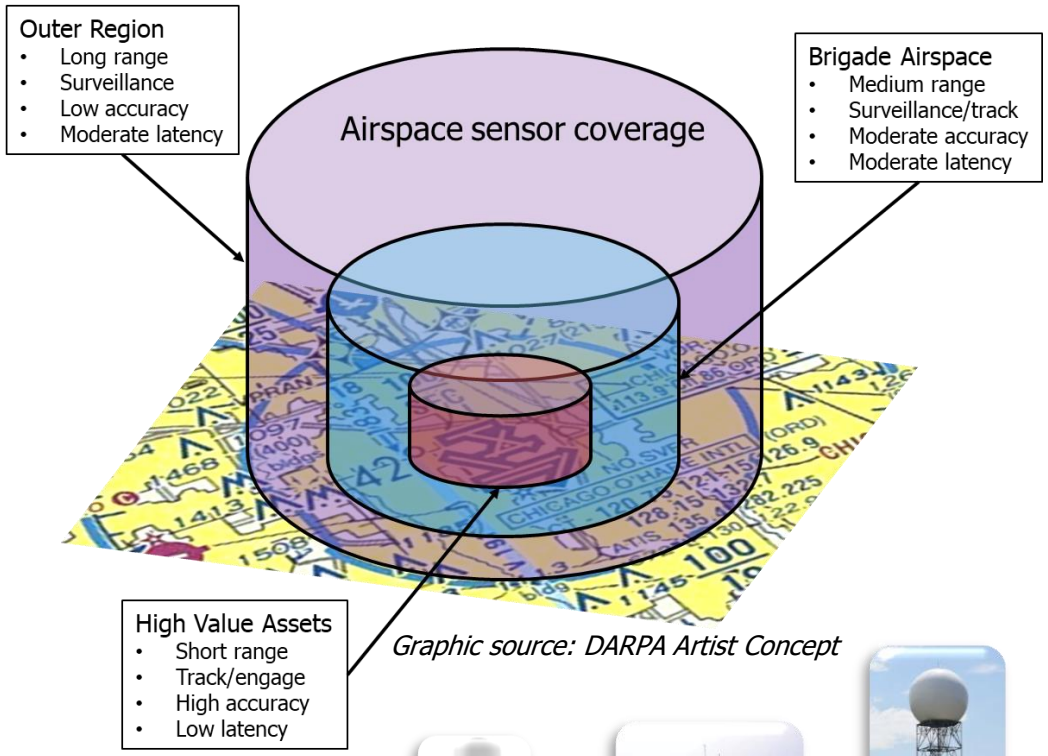
Capabilities

- Develops and executes sensor collection plans to monitor airspace operations against the plan, monitors plan and execution
- Refines airspace entity position and forecasts future position
- Resolves conflicts identified in airspace and fires plans by providing COAs and modifying plans
- Alerts operators to conflicts during operations, offers resolution, and provides risks and rationale

Potential Approaches

- Graph theory
- Reinforcement learning
- Global optimization with PSO
- Game theory to generate courses of action

TA2: Sensors



Graphic source: DARPA Artist Concept


Monostatic Radar


Electro-Optics Infrared


Counter-Mortar Radar


Weather Radar

Graphic source: Google Images


Radio Frequency Sensors


Laser Designator

Why now?

- Proliferation of electronic sensors and sources in the battlespace
- High-quality, low cost, commercial sensors
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

Capabilities

- Layered sensor coverage leveraging a variety of traditional and non-traditional sensors to refine entity location
  - Radars leveraging diverse sources
  - Electro-optic and infrared sensors
  - Electronic warfare sensors to detect communication
  - IFF, ADS-B, and PLI transitions
  - Intelligence, joint data feeds
- System interrogates sensors in real-time to verify predicted conflicts
- Planned and opportunistic sensor networks

IFF: Identification Friend or Foe
ADS-B: Automatic Dependent Surveillance - Broadcast
PLI: Position Location Information

System-of-Systems Sensor Approach

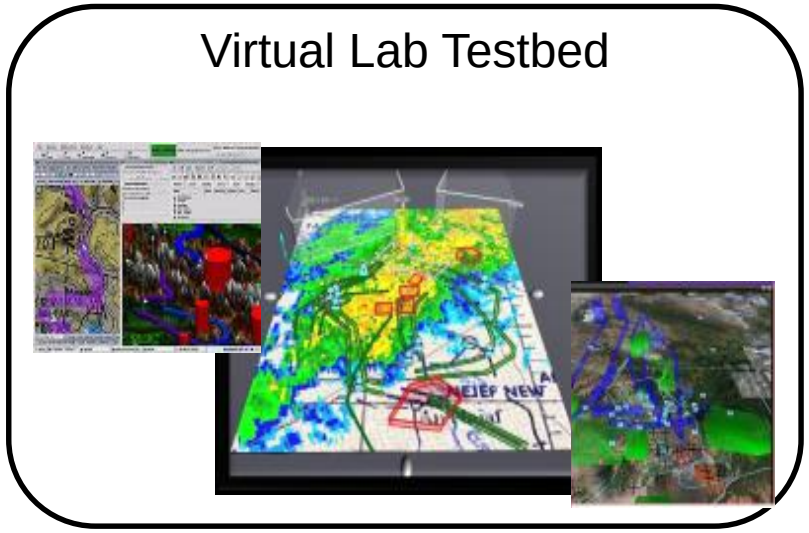
TA3: Virtual Lab Testbed

Why now?

- Computer processing power is now sufficient to handle the complexity of division airspace
- DEVOPS and virtual environments have reached a level of maturity capable of addressing the most complex airspace challenges
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

Capabilities

- Physics-based world model
- Virtual implementations of airspace planning tools for operator input and output, federated with legacy systems
- Open software framework to allow rapid insertion and experimentation with algorithms, sensors
- Simplifies transition path from laboratory to field



Graphic source: Army Research Laboratory

U.S.ARMY

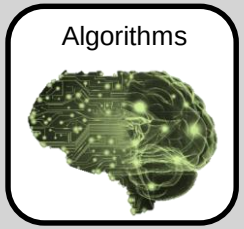
U.S. AIR FORCE

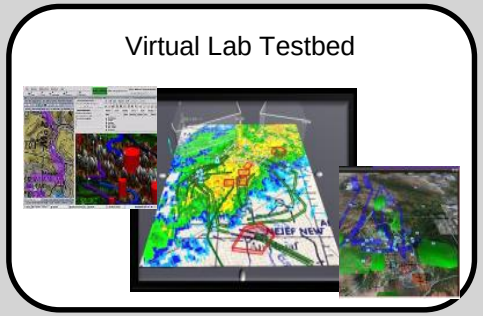
DEVOPS: Development and Operations

ASTARTE Development Concept

Phase 1
Component Development

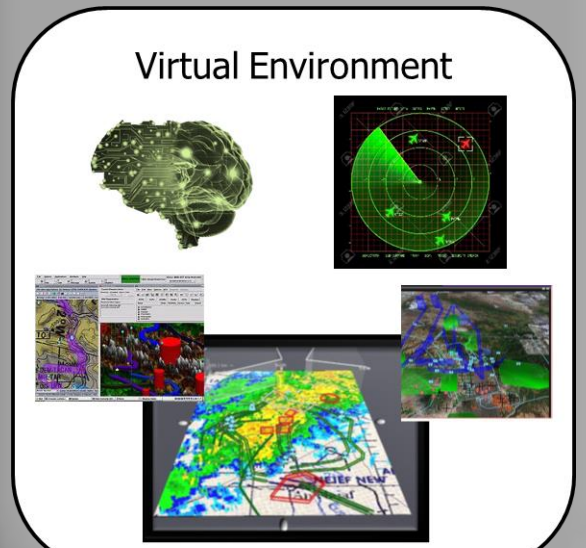
- Virtual Machine implementations of TAIS, AFATDS, TBMCS and other joint systems
- Algorithm development
- Sensor models and specifications
- Performance metric development and measurement approach





Phase 2
Virtual Environment

- Integration of algorithms and sensor models into Virtual Lab Testbed
- Improvements to algorithms and sensor models
- Performance assessments against metrics



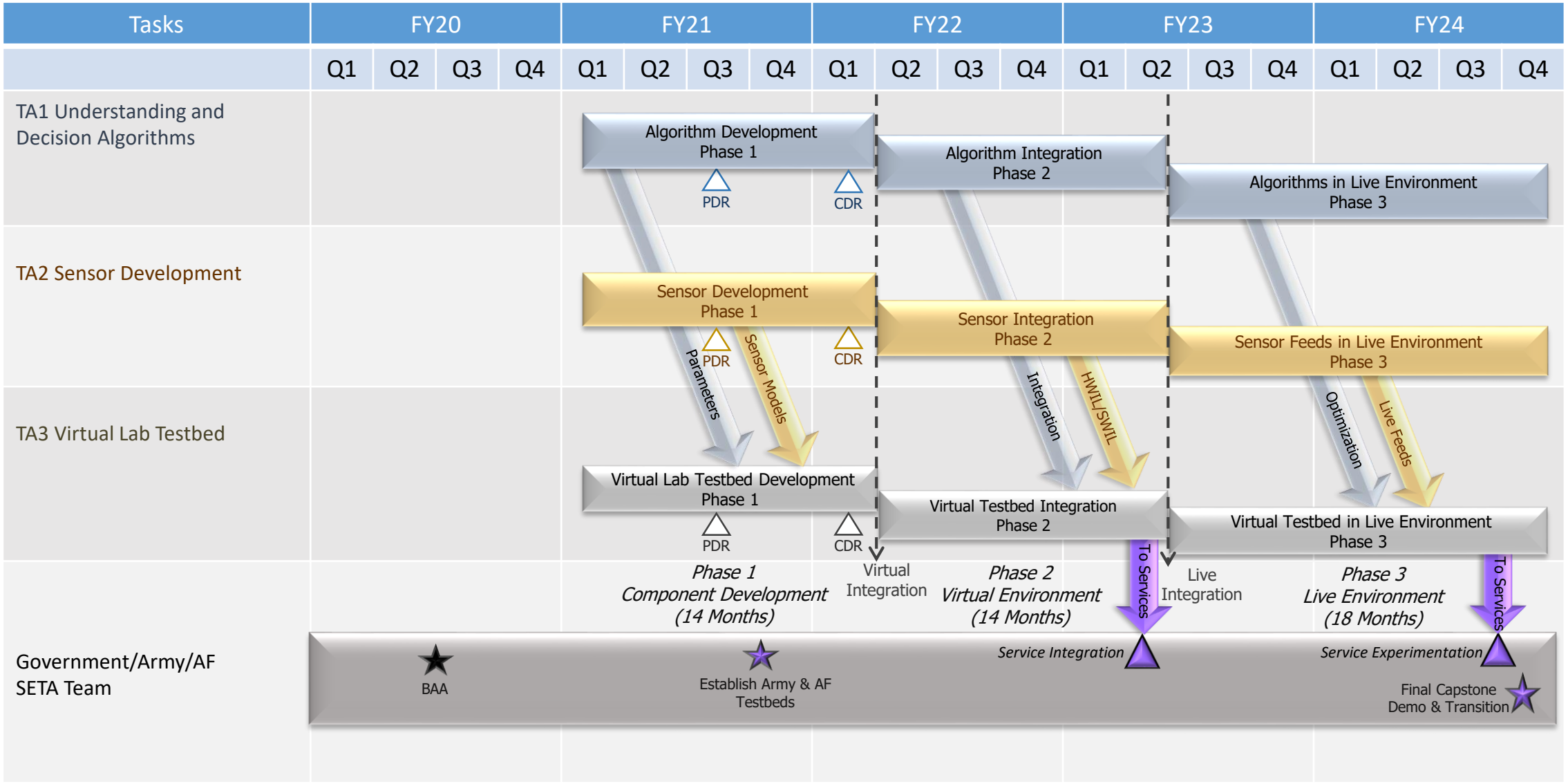
Phase 3
Live Environment

- Mission planning and operations with live TAIS, AFATDS, TBMCS and other joint systems in virtual world model
- Incorporate live sensor feeds into virtual world model
- Experiments at Combat Training Centers to demonstrate scenarios

TAIS: Tactical Airspace Integration System
AFATDS: Advanced Field Artillery Tactical Data System
TBMCS: Theatre Battle Management Core Systems

Graphic source: DARPA Artist Concept

ASTARTE Schedule and Milestones



Proposals to HR001120S0039

- Proposers must propose to all three technical areas in a single proposal
  - TA-1 Understanding and Decision Algorithms
  - TA-2 Sensors
  - TA-3 Virtual Lab Testbed

- It is strongly encouraged that proposers team with organizations that have specialized expertise in each technical area

- Proposers must have the ability to execute the entire program at the collateral SECRET level as a minimum
  - This requirement does not apply to organizations such as universities that may participate as a subcontractor

BAA Evaluation Criteria

Evaluation Criteria:	Expected Elements:
Overall Scientific and Technical Merit	• Technical approach is innovative, feasible, achievable, and complete • Identification of major technical risks and planned mitigation effort • Quality of proposed team must have experience and expertise • Description of prior experience including identification of government sponsors
Potential Contribution and Relevance to the DARPA Mission and Plans and Capability to Accomplish Technology Transition	• Must show support for DARPA Mission to make pivotal early technology investments • Capability to transition the technology to research, industrial, and/or operational military communities to enhance U.S. defense • Data rights and intellectual property ownership must be disclosed
Cost and Schedule Realism	• Proposed cost, labor categories and labor hours are consistent with statement of work • Fully scoped plan and schedule • Cost Risk

HR001120S0039 Important Dates

- Posting Date: April 7, 2020
- Proposers Day: April 21, 2020
- Abstract Due Date: April 28, 2020 4:00 PM (Eastern)
- Deadline to Notify Security of Intent to Submit Classified Data: May 28, 2020 4:00 PM (Eastern)
- Proposal Due Date: June 23, 2020 4:00 PM (Eastern)
- Security Classification Guide, DD254s, and Technical Interface Specifications will be mailed to proposers in a classified package after May 8th

- Deadline to Submit Questions: May 14, 2020 4:00 PM (Eastern)
- Submit Questions to: HR001120S0039@darpa.mil
- Frequently Asked Questions (FAQ) will be posted under HR001120S0039 summary on http://www.darpa.mil/work-with-us/opportunities

If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence